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PATENT APPLICATION
Docket No.: 2847.1001-011

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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| Applicant: | Gary J. Swanson |
| Serial No.: | 09/895,865 — Group: 2872 |
| Filed: | June 29, 2001 |
| For: | SYSTEM AND METHOD FOR EFFICIENT ILLUMINATION IN COLOR PROJECTION DISPLAYS |

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as First Class Mail in an envelope addressed to Assistant Commissioner for Patents, Washington, D.C. 20231

on September 25, 2001 (Date) Carol M. Brown (Signature)

Carol M. Brown
Typed or printed name of person signing certificate

## PRELIMINARY AMENDMENT

Box Missing Parts
Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Please amend the above-referenced patent application as follows:

In the Specification

Please delete the "ABSTRACT" paragraph at page 1, including the heading, "ABSTRACT", and the following lines numbered 1 through 8.

Please replace the paragraph at page 2, lines 1 through 3 with the following paragraph:

--GOVERNMENT SUPPORT

This invention was made with government support under contract number F19628-85-C-0002 awarded by the Air Force. The government has certain rights in the invention.--

Amendments to the specification are indicated in the attached "Marked Up Version of Amendments" (page i).

In the Claims

Please renumber Claims 14 through 27 to read 13 through 26, respectively.
Please renumber Claims 29 through 34 to read 27 through 32, respectively.
Additionally, please amend the claims as shown to correct self-evident errors in format.

1. A method for displaying a color image comprising the steps of:

illuminating a multilevel optical phase element with a light source having a plurality of wavelengths of interest, said multilevel phase element dispersing light from said light source by diffraction and focusing the dispersed light onto an imaging plane; and actuating a light modulating display in the imaging plane having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, within the near field region of said multilevel display element so as to receive said dispersed and focused light from said multilevel optical phase element.

3. The method of claim 1 further comprising providing a light source having a polychromatic spectrum.

4. The method of claim 1 further comprising providing a plurality of subsources each subsource having a different spectral distribution.

5. The method of claim 4 further comprising emitting light from each said subsource with a light emitting diode.

6. The method of claim 4 further comprising providing a laser at each said subsource.

7. The method of claim 1 further comprising providing a multilevel optical phase element that is multilevel in two orthogonal directions.

10. A method for displaying a color image comprising the steps of:

focusing light, from a light source having a plurality of wavelengths of interest, using a plurality of focusing elements;

illuminating a multilevel optical phase element with light focused by said plurality of focusing elements, said multilevel phase element dispersing light from said plurality of focusing elements by diffraction and focusing the dispersed light onto an imaging plane; and

actuating a light modulating display in the imaging plane having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, so as to receive said dispersed light from said multilevel optical phase element.

11. The method of claim 10 further comprising providing said plurality of focusing elements including a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{2T^2Z_s}{3\lambda_{long}Z_s-2T^2}<Z<\frac{2T^2Z_s}{3\lambda_{short}Z_s-2T^2}$$

wherein T is the periodicity of said multilevel optical phase element, $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

12. The method of claim 11 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{2T^2Z_s}{3\lambda_{long}Z_s-2T^2}<Z<\frac{2T^2Z_s}{3\lambda_{short}Z_s-2T^2}$$

wherein T is the periodicity of said multilevel optical phase element, $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

13. The method of claim 11 wherein said multilevel optical phase element is constructed such that a magnification produced by said plurality of lenslets produces a dispersion element of a size substantially equal to the dimensions of each pixel element in said display.

14. The method of claim 13 wherein said magnification (M) is given by the equation:

$$M = 1 + \frac{Z}{Z_s}$$

wherein T is the periodicity of said multilevel optical phase element, $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets and Z is the distance between said multilevel optical phase element and said display.

15. A system for displaying a color image comprising:

a light source emitting a plurality of wavelengths of interest;

a multilevel optical phase element positioned to receive light from said light source, said multilevel phase element dispersing light from said light source by diffraction and focusing the dispersed light onto an imaging plane; and

a light modulating electronic display positioned in the imaging plane and having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, positioned within the near field region of said multilevel optical phase so as to receive said dispersed light from said multilevel phase element.

16. The system of claim 15 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{T^2}{3\lambda_{Long}} < Z < \frac{2T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, $\lambda_{Long}$ is the longest wavelength of said plurality of wavelengths of interest and $\lambda_{Short}$ is the shortest wavelength of said plurality of wavelengths of interest.

17. The system of claim 16 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{2T^2}{3\lambda_{Long}} < Z < \frac{2T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, $\lambda_{Long}$ is the longest wavelength of said plurality of wavelengths of interest and $\lambda_{Short}$ is the shortest wavelength of said plurality of wavelengths of interest.

18. The system of claim 16 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{T^2}{3\lambda_{Long}} < Z < \frac{T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, $\lambda_{Long}$ is the longest wavelength of said plurality of wavelengths of interest and $\lambda_{Short}$ is the shortest wavelength of said plurality of wavelengths of interest.

19. The system of claim 16 wherein said light source has a polychromatic spectrum.

20. The system of claim 15 wherein said light source comprises a plurality of subsources each subsource having a different spectral distribution.

21. The system of claim 20 wherein each said subsource is a light emitting diode.

22. The system of claim 20 wherein each said subsource is a laser.

23. The system of claim 15 wherein said multilevel optical phase element is multilevel in two orthogonal directions.

24. A system for displaying a color image comprising:

a light source having a plurality of wavelengths of interest;

a plurality of focusing elements positioned to focus light from said light source;

a multilevel optical phase element positioned to receive light focused by said plurality of focusing elements, said multilevel phase element dispersing light from said plurality of focusing elements by diffraction and focusing the dispersed light onto an imaging plane; and

a light modulating electronic display positioned in the imaging plane and having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined

spectral region, positioned so as to receive said dispersed light from said multilevel optical phase element.

25. The system of claim 24 wherein said plurality of focusing elements comprises a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{2T^2Z_s}{3\lambda_{long}Z_s-2T^2}<Z<\frac{2T^2Z_s}{3\lambda_{short}Z_s-2T^2}$$

wherein T is the periodicity of said multilevel optical phase element, $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets, $\lambda_{long}$ is the largest wavelength of said plurality of wavelengths of interest and $\lambda_{short}$ is the shortest wavelength of said plurality of wavelengths of interest.

26. The system of claim 25 wherein said plurality of focusing elements comprises a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{2T^2Z_s}{3\lambda_{long}Z_s-2T^2}<Z<\frac{2T^2Z_s}{3\lambda_{short}Z_s-2T^2}$$

wherein T is the periodicity of said multilevel optical phase element, $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets, $\lambda_{long}$ is the largest wavelength of said plurality of wavelengths of interest and $\lambda_{short}$ is the shortest wavelength of said plurality of wavelengths of interest.

27. The system of claim 24 wherein said multilevel optical phase element is constructed such that a magnification produced by said plurality of lenslets produces a dispersion element substantially equal to the dimensions of each pixel element in said display.

28. The system of claim 27 wherein said magnification (M) is given by the equation:

$$M = 1 + \frac{Z}{Z_s}$$

wherein T is the periodicity of said multilevel optical phase element, Z is the distance between said multilevel optical phase element and said display and $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

29. The system of claim 24 wherein said multilevel optical phase element is multilevel in two orthogonal directions.

30. The system of claim 24 wherein said light source comprises a plurality of subsources each subsource having a different spectral distribution.

31. The system of claim 30 wherein each said subsource is a light emitting diode.

32. The system of claim 30 wherein each said subsource is a laser.

Amendments to the claims are indicated in the attached "Marked Up Version of Amendments" (pages i - viii).

In the Abstract

As requested in a Notice to File Missing Parts, mailed from the U.S. Patent and Trademark Office on July 25, 2001, please add the following Abstract of the Disclosure as new page 36:

--SYSTEM AND METHOD FOR EFFICIENT ILLUMINATION
IN COLOR PROJECTION DISPLAYS

ABSTRACT OF THE DISCLOSURE

A multilevel optical phase element is illuminated with a light source having a plurality of wavelengths of interest. The multilevel phase element disperses light from the light source by diffraction and focuses the dispersed light onto an imaging plane. A light modulating display in the imaging plane having a plurality of pixel elements is actuated. Each pixel element is assigned to transmit a predetermined spectral region within the near field region of the multilevel display element so as to receive the dispersed and focused light from the multilevel optical phase element. A system for displaying a color image includes a light source emitting a plurality of

wavelengths of interest, a multilevel optical phase element, and a light modulating electronic display.--

## REMARKS

An abstract on a separate sheet was requested by a Notice to File Missing Parts issued by the U.S. Patent and Trademark Office on July 25, 2001. Applicant includes with this Preliminary Amendment the requested abstract on new page 36, which is enclosed herewith. Support for the Abstract of the Invention can be found in the specification at, for example, Claims 1 and 16.

Applicant is amending numbering of Claims 14-27 and 29-34 because the application, as filed, did not include claims numbered 13 or 28. If this amendment is not entered, Applicant will refer to the claims as originally numbered during prosecution. Also, Applicant is amending the claims to correct self-evident errors. No new matter has been added.

If the Examiner believes that a telephone conversation would be helpful in expediting the prosecution of this application, the Examiner is requested to call the undersigned at (781) 861-6240.

Respectfully submitted,

HAMILTON, BROOK, SMITH & REYNOLDS, P.C.

By ________________________________

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Lexington, Massachusetts 02421-4799
Dated: 9/25/01

## MARKED UP VERSION OF AMENDMENTS

### Specification Amendments Under 37 C.F.R. § 1.121(b)(1)(iii)

Replace the paragraph at page 2, lines 1 through 3 with the below paragraph marked up by way of underlining to show the change relative to the previous version of the paragraph.

### GOVERNMENT SUPPORT

This invention was made with government support under contract number F19628-85-C-0002 awarded by the Air Force. The government has certain rights in the invention.

### Claim Amendments Under 37 C.F.R. § 1.121(c)(1)(ii)

1. (Amended) [(Amended)] A method for displaying a color image comprising the steps of:
   illuminating a multilevel optical phase element with a light source having a plurality of wavelengths of interest, said multilevel phase element dispersing light from said light source by diffraction and focusing the dispersed light onto an imaging plane; and actuating a light modulating display in the imaging plane having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, within the near field region of said multilevel display element so as to receive said dispersed and focused light from said multilevel optical phase element.

3. (Amended) [(Amended)] The method of claim 1 further comprising providing a light source having a polychromatic spectrum.

4. (Amended) [(Amended)] The method of claim 1 further comprising providing a plurality of subsources each subsource having a different spectral distribution.

5. (Amended) [(Amended)] The method of claim 4 further comprising emitting light from each said subsource with a light emitting diode.

6. (Amended) [(Amended)] The method of claim 4 further comprising providing a laser [as] at each said subsource.

7. (Amended) [(Amended)] The method of claim 1 further comprising providing a multilevel optical phase element that is multilevel in two [othogonal] <u>orthogonal</u> directions.

10. (Amended) [(Amended)] A method for displaying a color image comprising the steps of:

focusing light, from a light source having a plurality of wavelengths of interest, using a plurality of focusing elements;

illuminating a multilevel optical phase element with light focused by said plurality of focusing elements, said multilevel phase element dispersing light from said plurality of focusing elements by diffraction and focusing the dispersed light onto an imaging plane; and

actuating a light modulating display in the imaging plane having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, so as to receive said dispersed light from said multilevel optical phase element.

11. (Amended) [(Amended)] The method of claim 10 further comprising providing said plurality of focusing elements including a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[ \left| \frac{T^2 Z_s}{3\lambda_{long} Z_s - T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2} \right| \right.$$

$$\left. \underline{\frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2}} \right]$$

$$\underline{\frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2}}$$

wherein T is the periodicity of said multilevel optical phase element, $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

12. (Amended) The method of claim 11 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[\left[\frac{T^2 Z_s}{3\lambda_{long} Z_s - T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2}\right]\right.$$

$$\frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2}$$

$$\left.\underline{\hspace{8cm}}\right]$$

$$\frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2}$$

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wherein T is the periodicity of said multilevel optical phase element, $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

[14]<u>13</u>. (Amended) The method of claim 11 wherein said multilevel optical phase element is constructed such that a magnification produced by said plurality of lenslets produces [an] <u>a</u> dispersion element of a size substantially equal to the dimensions of each pixel element in said display.

[15]<u>14</u>. (Amended) The method of claim [14] <u>13</u> wherein said magnification (M) is given by the equation:

$$M = 1 + \frac{Z}{Z_s}$$

wherein T is the periodicity of said multilevel optical phase element, $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets and Z is the distance between said multilevel optical phase element and said display.

[16]15. (Amended) [(Amended)] A system for displaying a color image comprising:

a light source emitting a plurality of wavelengths of interest;

a multilevel optical phase element positioned to receive light from said light source, said multilevel phase element dispersing light from said light source by diffraction and focusing the dispersed light onto an imaging phase; and

a light modulating electronic display positioned in the imaging plane and having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, positioned within the near field region of said multilevel optical phase so as to receive said dispersed light from said multilevel phase element.

[17]16. (Amended) The system of claim [16] 15 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{T^2}{3\lambda_{Long}} < Z < \frac{2T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, $\lambda_{Long}$ is the longest wavelength of said plurality of wavelengths of interest and $\lambda_{Short}$ is the shortest wavelength of said plurality of wavelengths of interest.

[18]17. (Amended) The system of claim [17] 16 wherein said display is positioned at a distance from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{2T^2}{3\lambda_{Long}} < Z < \frac{2T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, $\lambda_{Long}$ is the longest wavelength of said plurality of wavelengths of interest and $\lambda_{Short}$ is the shortest wavelength of said plurality of wavelengths of interest.

[19]18. (Amended) The system of claim [17] 16 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{T^2}{3\lambda_{Long}} < Z < \frac{T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, $\lambda_{Long}$ is the longest wavelength of said plurality of wavelengths of interest and $\lambda_{Short}$ is the shortest wavelength of said plurality of wavelengths of interest.

[20]19. (Amended) [(Amended)] The system of claim [17] 16 wherein said light source has a polychromatic spectrum.

[21]20. (Amended) The system of claim [16] 15 wherein said light source comprises a plurality of subsources each subsource having a different spectral distribution.

[22]21. (Amended) The system of claim [21] 20 where'n each said subsource is a light emitting diode.

[23]22. (Amended) The system of claim [21] 20 wherein each said subsource is a laser.

[24]23. (Amended) The system of claim [16] 15 wherein said multilevel optical phase element is multilevel in two [othagonal] orthogonal directions.

[25]24. (Amended) [(Amended)] A system for displaying a color image compri sing[;]:
a light source having a plurality of wavelengths of interest;
a plurality of focusing elements positioned to focus light from said light source;
a multilevel optical phase element positioned to receive light [focused] focused by said plurality of focusing elements, said multilevel phase element dispersing light from sail plurality of focusing elements by diffraction and focusing the dispersed light onto an imaging plane; and

a light modulating electronic display positioned in the imaging plane and having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, positioned so as to receive said dispersed light from said multilevel optical phase element.

[26]25. (Amended) [(Amended)] The system of claim [25] 24 wherein said plurality of focusing elements comprises a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[ \left[ \frac{T^2 Z_s}{3\lambda_{long} Z_s - T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2} \right] \quad \frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2} \right]$$

$$\frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2}$$

wherein T is the periodicity of said multilevel optical phase element, $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets, $\lambda_{long}$ is the largest wavelength of said plurality of wavelengths of interest[;] and $\lambda_{short}$ is the shortest wavelength of said plurality of wavelengths of interest.

[27]26. (Amended) The system of claim [26] 25 wherein said plurality of focusing elements comprises a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[\frac{2T^2Z_s}{3\lambda_{long}Z_s - 2T^2} < Z < \frac{2T^2Z_s}{3\lambda_{short}Z_s - 2T^2}\right]$$

$$\frac{2T^2Z_s}{3\lambda_{long}Z_s\text{-}2T^2} < Z < \frac{2T^2Z_s}{3\lambda_{short}Z_s\text{-}2T^2}$$

wherein T is the periodicity of said multilevel optical phase element, $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets, $\lambda_{long}$ is the largest wavelength of said plurality of wavelengths of interest[;] and $\lambda_{short}$ is the shortest wavelength of said plurality of wavelengths of interest.

[29]27. (Amended) The system of claim [25] 24 wherein said multilevel optical phase element is constructed such that a magnification produced by said plurality of lenslets produces [an] a dispersion element substantially equal to the dimensions of each pixel element in said display.

[30]28. (Amended) The system of claim [29] 27 wherein said magnification (M) is given by the equation:

$$M = 1 + \frac{Z}{Z_s}$$

wherein T is the periodicity of said multilevel optical phase element, Z is the distance between said multilevel optical phase element and said display and $Z_s$ is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

[31]29. (Amended) The system of claim [25] 24 wherein sail multilevel optical phase element is multilevel in two [othagonal] orthogonal directions.

[32]30. (Amended) The system of claim [25] 24 wherein said light source comprises a plurality of subsources each subsource having a different spectral distribution.

[33]31. (Amended) The system of claim [32] 30 wherein each said subsource is a light emitting diode.

[34]32. (Amended) The system of claim [32] 30 wherein each said subsource is a laser.